



How does color help us understand images from space?



Investigation Overview

Students learn to interpret colors in images from space. A mapping activity helps them to recognize global vegetation patterns from colors seen in satellite images. They also distinguish between true color and false color images, and examine how geographers and scientists use false color images to study the surface of Earth.

Time required: Two 45-minute sessions

Materials/Resources

Monitor image: *Little Red Riding Hood in the Forest* <http://spaceplace.jpl.nasa.gov/eo1_1.htm> (Note: This image should be shown on a monitor.)

Log 1: Mapping the global biosphere—Map (one copy for each student)

Log 2: Mapping the global biosphere—Questions (one copy for each student)

Log 3: Mapping the global biosphere—Chart (one copy for each student)

Color Transparency 1: First image of the global biosphere

Color Transparency 2: Phoenix—True color

Color Transparency 3: Phoenix—False color

Color Transparency 4: Washington, D.C.—False color

Content Preview

The biosphere is the realm of Earth that includes all plant and animal life forms. Geographers divide the biosphere into regions called biomes. A biome is a very large ecological region within which plant and animal communities are adapted to the physical environment (climate and soil). The major biomes are forest, savanna, grassland, and desert. Oceans contain plant life too, including plankton. Satellite images sometimes employ “false” color to make analysis of images easier.

Classroom Procedures

Beginning the Investigation

1. Tell the students that satellites allow us to see images of the entire Earth. Show them **Color Transparency 1**: First image of the global biosphere.
2. Explain that the biosphere is the part of Earth in which living plants and animals exist. This image was created from many smaller images. It was the first global image of plant life.

Geography Standards

Standard 1: The World in Spatial Terms

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

- Identify and describe the characteristics and purposes of geographic representations, tools, and technologies.

Standard 8: Physical Systems

The characteristics and spatial distribution of ecosystems on Earth's surface

- Identify and explain the distribution and patterns of ecosystems.

Geography Skills

Skill Set 1: Analyzing Geographic Information

- Use maps or observe and interpret geographic relationships.

Developing the Investigation

- Ask students if these are the actual colors you would see if you were able to look down at Earth from space. Help them to observe that the colors have been simplified. In reality, continents are not only green and yellow, but these colors have been used in the image to look similar to Earth's colors and also to help us understand what the vegetation is like. Green represents vegetation, and the darker the color, the more intense the growth. In the hot, wet tropics, the green is darkest. Yellow represents little plant life. Point out the locations of the large deserts in the image.
- Ask students what kind of plant life there is in the oceans. Explain that plankton are very small plants that are important sources of food for the animals that live in the oceans. Instruments on the satellites can tell where there are concentrations of plankton and these can be colored in satellite images to make it easier to see them.
- Tell students that they will be making a map of the global biosphere. Give them copies of **Log 1**. Have them use the legend to color the map. Explain that biomes are regions that have similar environments and plants and animals that have adapted to live in these environments. On the map they will identify three basic biomes. When the maps are completed, have the class speculate about how such maps can be useful.
- Then distribute copies of **Log 2** and **Log 3**. Have students work in pairs and use the map to complete **Logs 2** and **3**. Then discuss their answers with the class.

Concluding the Investigation

- Using a computer projector or monitor, show *Little Red Riding Hood in the Forest*. Ask the students to explain what they see in the picture. Explain that there are many different types of trees in the forest and that they are represented by many different shades of green. Ask if they think that scientists can discern different species by their shades of green. (*Sometimes they can but sometimes the shades are too close.*)
- Now move the mouse over the picture and ask the students what happens to the colors of the trees. (*As you move the mouse over the forest, the colors change from different shades of green to pastel colors of pink, purple, yellow, etc.*) Explain that computers can change the different shades of green into other colors that are easier to differenti-

ate. These are called "false" colors because they are not the natural (or "true") colors of vegetation. Go to the last illustration on this site and show the class the two images of a real forest. How many species can they identify in the false color image?

- Ask the students why it is important to see such details from space. (*Climate changes, pollution, and human activity may all cause changes in the species of trees.*)

Ask students why it is important to monitor such changes. (*The local economy could be affected if the new species are less valuable to the timber industry; wildlife habitats could be affected; if the new species are more disease-prone, they could more easily be destroyed.*) Diseases that affect certain kinds of trees can be controlled better if those species can be picked out by their color on satellite images. The kinds of crops that are grown throughout the country can also easily be monitored if different crops show up as different colors. Color also can be used to indicate the health of trees.

- Looking at images.** Show students **Color Transparency 2: Phoenix—True color image** and **Color Transparency 3: Phoenix—False color image**. Ask them to describe the differences between the true and false color images.
 - Can they guess what is shown in red in the false color image? Hint: It is green in the true color image. (*Vegetation.*)
 - How might this false color image be useful? Could you use it to distinguish the downtown from the suburbs? To locate parks and golf courses? Note that the area around Phoenix is very dry. Most of the vegetation needs irrigation to grow. Notice the square and rectangular pattern of the vegetation, which conforms to property boundaries.
- Now look at **Color Transparency 4: Washington, D.C.—False color**. The brighter the red color, the more intense the growth of the vegetation. Have the students find downtown and identify several parks. In the middle of the downtown area, above the confluence of the Potomac and Anacostia Rivers (to the west and east, respectively), lies the Capitol. You can see the building clearly because it is surrounded by parkland. Extending from the Capitol to the west is the Washington Mall, a grassy area along which several large museums are located. The White House is in a park-like area that extends north from the mall.

Discuss the merits of false color in identifying the parkland. Ask students how false color is used to identify buildings and pavement. (*They are bright green.*)

Discuss the true colors of the buildings (actually rooftops in this perspective) and pavement. Ask why the grey and black true colors would be more difficult to see than the false color. (*They do not stand out and they tend to blend.*)

12. In closing, compare this image with the one of Phoenix. What can we tell about the climate of each place? (*Phoenix is much drier. It has less vegetation, and most of it is in smaller areas that show property lines. Washington, D.C., has more large areas of vegetation.*)

Evaluation

*Log 1: Mapping the global biosphere—Map

Check maps to see if students matched numbers and colors correctly.

*Log 2: Mapping the global biosphere—Questions

- Explain how the #3 on Africa is different from the #3 on Antarctica.
The #3 on Africa is the Sahara Desert region, and the #3 on Antarctica is the ice desert region.
- Where are the tropical forests and grasslands located?
The tropical forests and grasslands are found near the Equator.
- Identify all the biomes located in the United States.
The United States has temperate forests, temperate grasslands, mountains, deserts, and ice biomes.
- Name the continents that have mountains, deserts, or ice.
North America, South America, Africa, Europe, Asia, Australia, and Antarctica
- How might scientists use your map of the global biosphere to study our planet?
Any reasonable answer such as they can study changes to the environment on the continents over time, see how different biospheres are changing, etc.

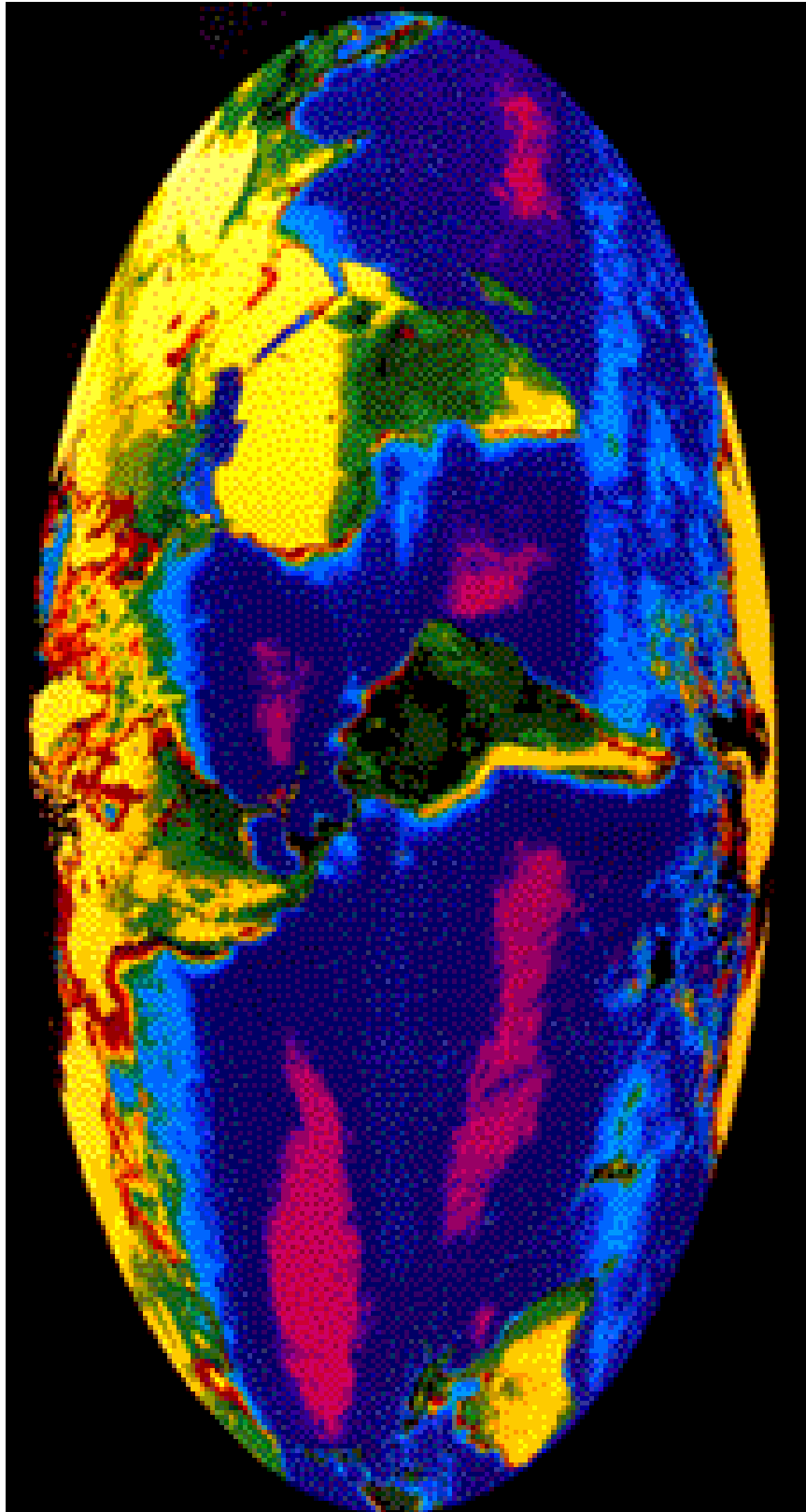
*Log 3: Mapping the global biosphere—Chart

| North America | South America |
|---|---|
| Temperate Forests Temperate Grasslands Mountains Deserts Ice | Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice |
| Africa | Europe |
| Tropical Forests Tropical Grasslands Mountains Deserts Ice | Temperate Forests Temperate Grasslands Mountains Deserts Ice |
| Asia | Australia |
| Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice | Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice |
| Antarctica | |
| Mountains Deserts Ice | |

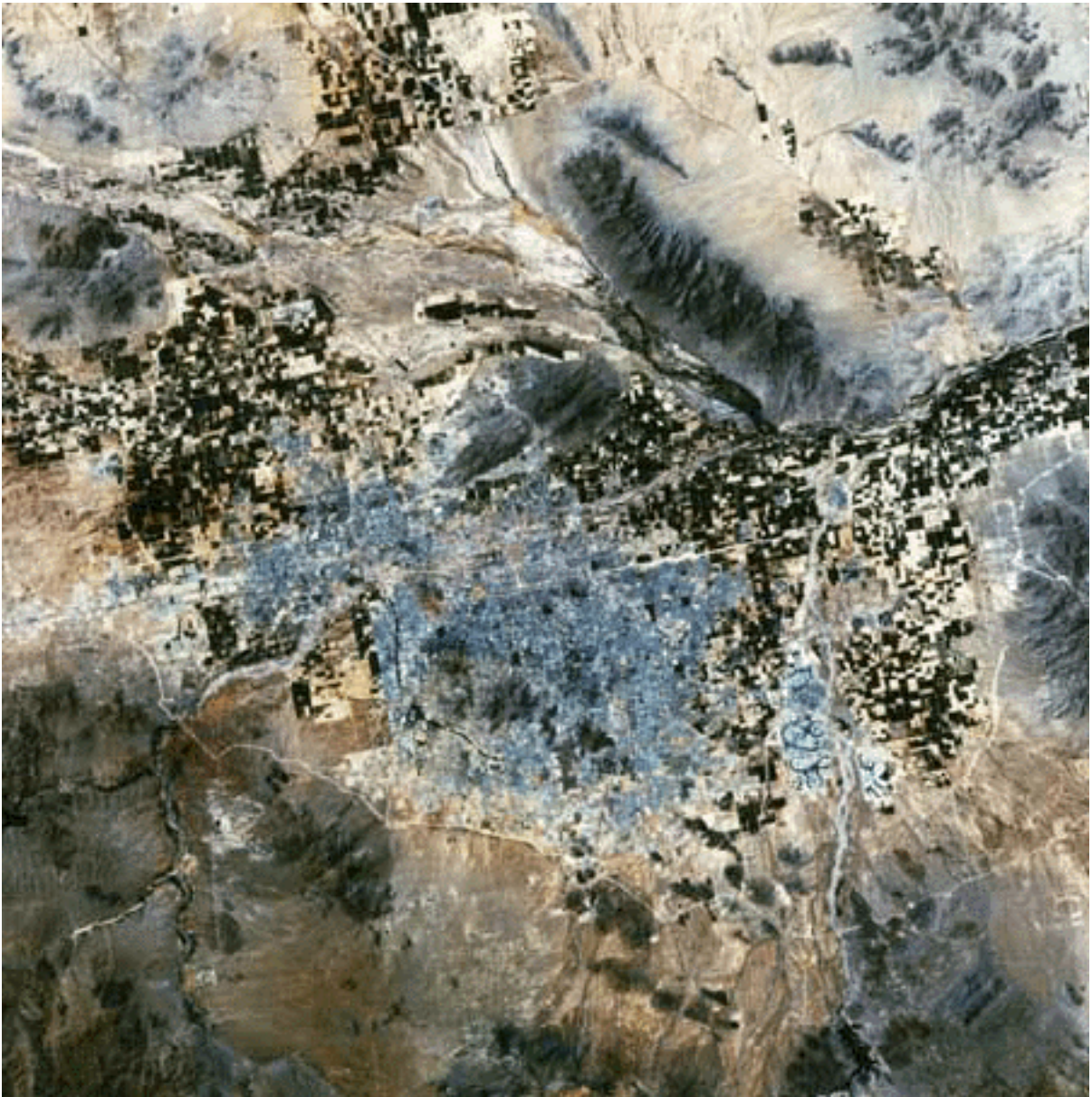
References

<http://kids.earth.nasa.gov/archive/coloring/4/index.html> Image of global biosphere
http://spaceplace.jpl.nasa.gov/eo1_1.htm Little Red Riding Hood in the Forest
<http://imagers.gsfc.nasa.gov/teachersite/RsImage2.html> Phoenix—True color image
<http://imagers.gsfc.nasa.gov/teachersite/RsImage3.html> Phoenix—False color image
<http://earth.jsc.nasa.gov/lores.cgi?PHOTO=STS068-209-067> Mackinaw, Michigan—False color
<http://pao.gsfc.nasa.gov/gsf/EARTH/PICTURES/Landsat/washlith.jpg> Washington, D.C.—False color

Color Transparency 1: First image of the global biosphere

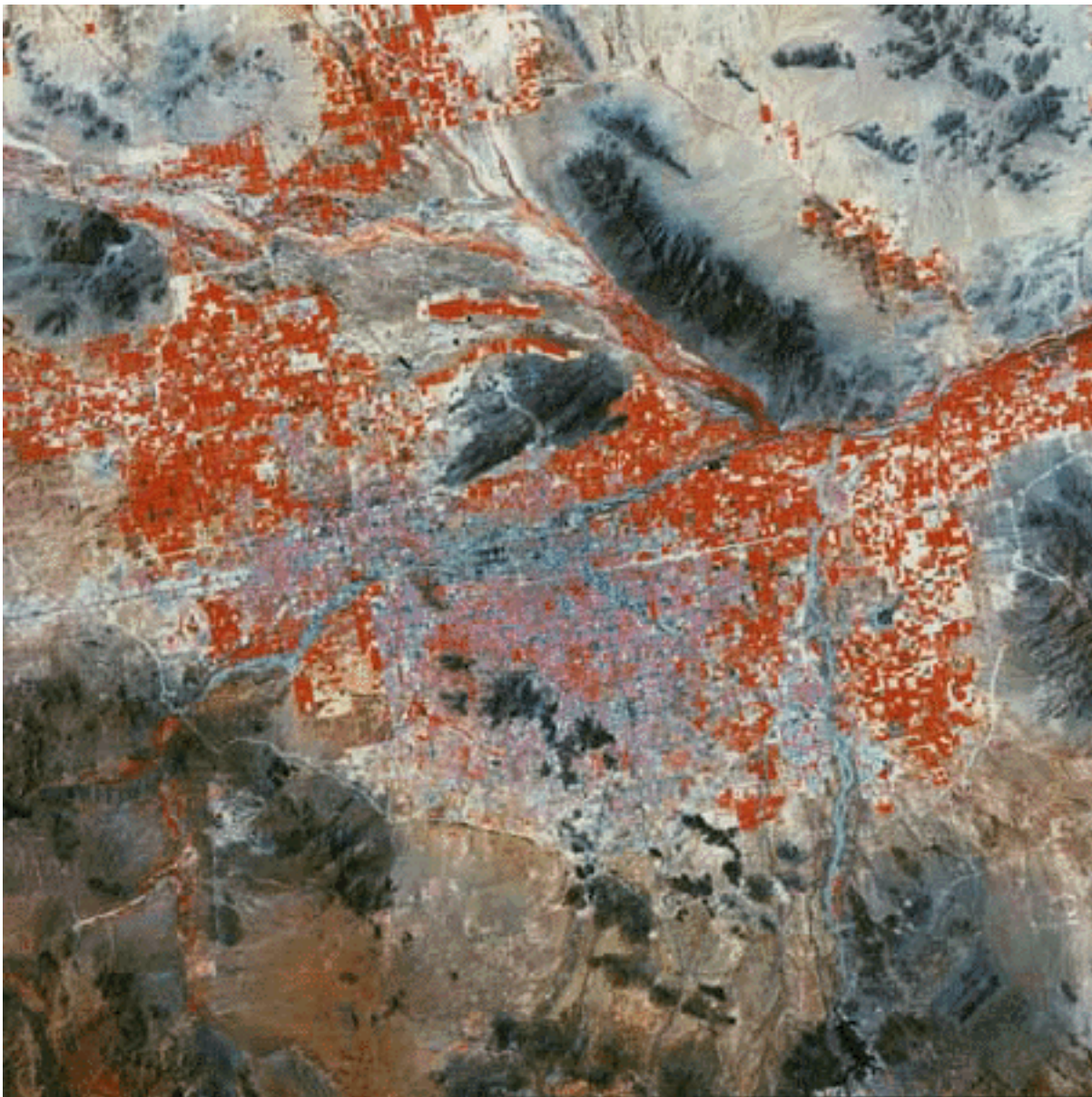


Color Transparency 2: Phoenix—True color



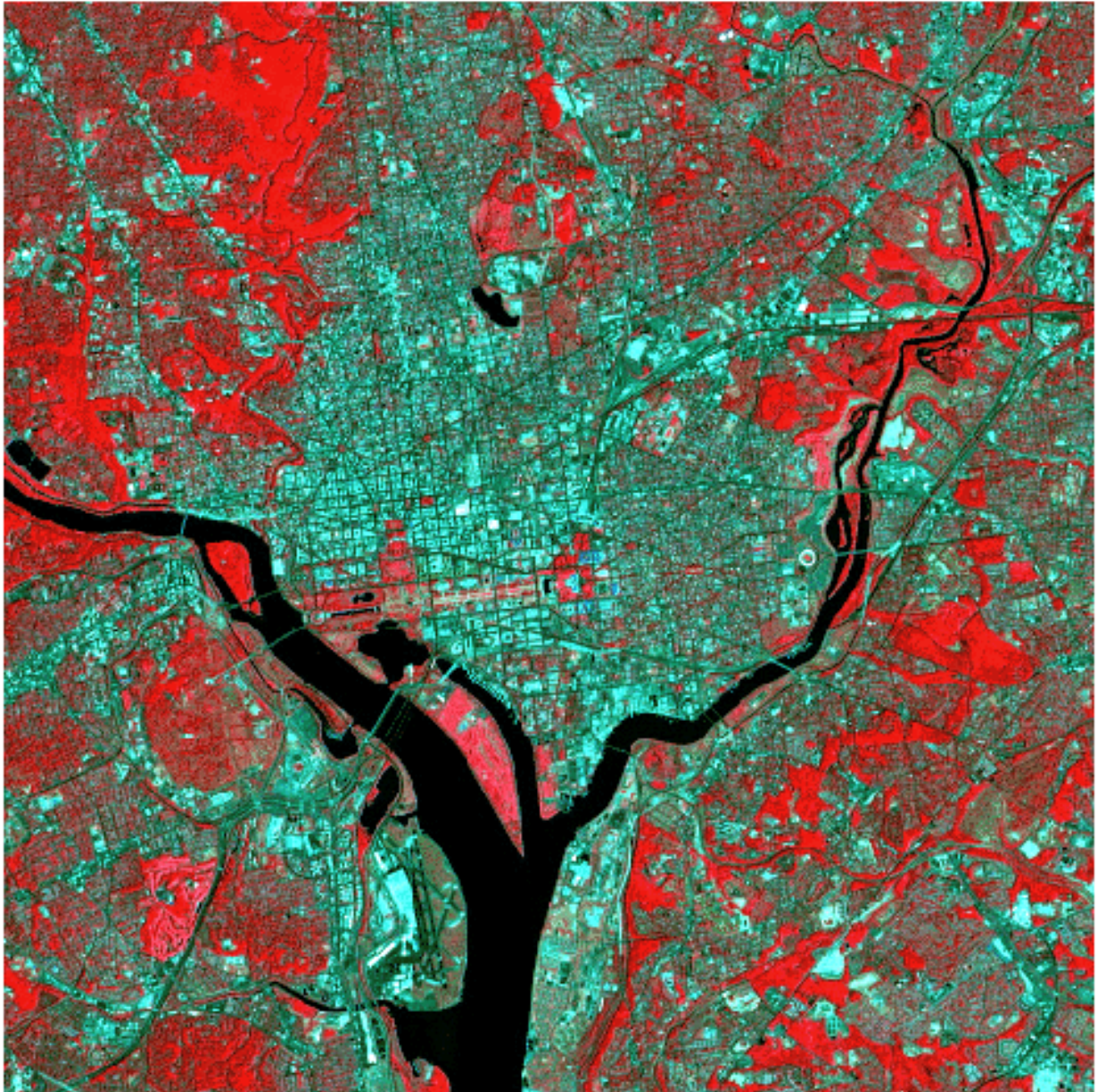
Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage2.html>

Color Transparency 3: Phoenix—False color



Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage3.html>

Color Transparency 4: Washington D.C.—False color



Source: <http://pao.gsfc.nasa.gov/gsfcc/EARTH/PICTURES/Landsat/washliith.jpg>



Module 1, Investigation 4: Log 1

Mapping the global biosphere—Map



Directions:

- Use the key/legend to color the land
- Label the oceans
- Color oceans light blue

Biomes

- 1 - Dark Green - Tropical Forests and Tropical Grasslands
- 2 - Light Green - Temperate Forests and Temperate Grasslands
- 3 - Yellow - Mountains, Deserts, and Ice



Module 1, Investigation 4: Log 2

Mapping the global biosphere—Questions

Name _____ Date _____

Use your map of the global biosphere to answer the following questions.

1. Explain how the #3 on Africa is different from the #3 on Antarctica.

2. Where are the tropical forests and tropical grasslands located?

3. Identify all the biomes located in the United States.

4. Name the continents that have mountains, deserts, or ice.

5. How might scientists use your map of the global biosphere to study our planet?



Module 1, Investigation 4: Log 3

Mapping the global biosphere—Chart

Name _____ Date _____

Directions: Use the map to complete the chart. Look carefully at each of the continents and on the chart list the biomes located on each of them.

| North America | | South America | |
|---------------|-----------|---------------|------------|
| | | | |
| Africa | | Europe | |
| | | | |
| Asia | Australia | | Antarctica |
| | | | |